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Combat Crew

strategic air command

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OCTOBER 1977

FLARE

Combat Crew

Magazine of the Strategic Air Command - 28th Year of Publication

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ON OUR COVER

Depicted is the T-38 which is being used in the Accelerated Copilot Enrichment (ACE) program. For more information on the subject, see page 12.

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General Richard H. Ellis
Commander in Chief, SAC

CINCSAC COMMENTS

A VIEW OF SAFETY

As the new Commander in Chief of SAC, I'm pleased to be able to address a few words to you, the combat crewmembers, who are the **sine qua non** of our profession. Because my background is flying oriented, my first remarks will be primarily focused toward flying crews.

My approach to safety in every realm is what might best be called "the conservative approach."

The conservative approach means that we realize that peacetime training requirements cannot be equated with wartime combat requirements in terms of mission execution at any cost. The risk of losing crews or equipment simply to complete a training mission is not justified under any circumstances.

All of the Air Force has practiced the conservative approach to flying during the past few years. In 1948 we had an accident rate of 40 per 100,000 flying hours. Compare this with the 1976 rate of 2.8, with about the same number of flying hours. Of course, you don't reduce the accident rate from 40 to 2.8 without many changes in interrelated areas; and in particular, strong supervision over flying operations.

The equipment we're flying is better and safer, obviously, but there is another side to the story. Our weapon systems today are more complex with inherently higher performance and a correspondingly increased challenge to crewmembers of a much more diverse and demanding character.

The Air Force mission is a technical and tough business. SAC professionals in safety, flying Stan/Eval and MSET, continually evaluate and monitor our flying programs. All of these people share the credit for our accident rate reduction.

Conservative flying is a must. It doesn't matter from whose viewpoint you're talking. All commanders, supervisors and crewmembers, from the chief down, must "think" and practice conservative flying as a day-to-day approach to our air operations.

Certainly we cannot simulate wartime conditions such as the "pucker factor" found only in combat, or the urgency and necessity to accomplish a wartime mission. A wartime mission will be successfully accomplished through our tough, demanding training programs plus combat induced adrenalin. But, I feel SAC is producing crews capable of "cutting the job" in the event of hostilities. A reduction in flying experience of our crews makes for a tougher job that can only be compensated for by our commanders and supervisors.

The supervisor must continually orient new people to the mission. People change all the time. Equipment is constantly modified and modernized. Consequently, supervisors must keep up-to-date on this equipment, and insure that everyone is brought up to speed.

The orientation process is not solely a matter of emphasizing and improving standardized techniques and practices, but one of indoctrinating new people to insure that they understand changing equipment and techniques. This can partially be achieved by professional safety personnel who play an important role in the conservation of our personnel and equipment.

But, there's no doubt about the importance of each individual in the flying equation. Our equipment and procedures are only as good as the people we have to **use** equipment or **carry out** procedures. Our personnel must be qualified to handle the demands of our highly technological force.

If we were able to spend more time in the aircraft than we do now, our weapons systems and personnel would be better off. I don't like the reduction in flying time we've had to take during the last few years. But we must recognize national priorities and strive for the most combat capable force available within resources provided.

We can accomplish our mission by insuring that we get everything possible out of every hour we're in the air. The threat of even higher energy costs will take the individual and combined efforts of everyone — ground personnel, aircrews, and supervisors alike — to maintain required readiness levels.

I expect the simulators SAC and the Air Force will be purchasing over the next five years to be the most advanced available. We should be able to simulate the majority of the missions we're required to perform in our aircraft.

Simulators hopefully will bridge the gap of reduced flying hours. With improvement in the present state-of-the-art equipment, such as visual systems, enhanced radar simulation, and realistic motion cueing, our simulators will enable us to train by correcting mistakes on the ground that we just can't afford to have occur in the air. They will reduce cost and insure that aircrews have increased opportunities to develop the critical skills necessary for safe and effective combat training. But remember, simulators are only a tool to strengthen the experience that aircrews must gain from actual airmanship.

In this connection, **air discipline** is one subject that I haven't mentioned, and it goes hand-in-glove with safety and professionalism. Several recent accidents have resulted from crewmembers' failing to exercise proper air discipline; and on some occasions there have been outright violations of training and safety regulations.

I have the greatest sympathy for crews in trouble through no fault of their own, and pray for their survival. Those who do can help explain what happened after they get down. That is how we save other crews. But our Air Force has no place for people who violate our rules, endanger themselves, their fellow crewmembers, and risk tremendously expensive equipment.

For the past several years, our record in missile safety has shown steady improvement and the sound safety principles that enabled us to reach the present plateau must continue if we are to conserve this important part of our deterrent posture. I also feel that strong supervision, and effective training and standardization programs are twin essentials for safe missile operations and maintenance programs.

Continued on page 29

Change Without Notice!

Maj. LEWIS J. NEYLAND
HQ AIR WHEATHER SERVICE

Editor's note: The following article on wind shear was written several years ago by an experienced Air Force pilot, Maj Lewis J. Neyland, who served as a weather officer in the Operations Analysis Division, HQ Air Weather Service. It gives an interesting historical perspective, and also a good lead-in to promising new techniques in the prediction and measurement of wind shear, a perennially troublesome weather phenomenon.

THE OTHER NIGHT I was courageously doing a little hangar flying with some of the boys. The ensuing hairy stories had us pretty well convinced that most of the hazards of the good old days are long gone. No more tearing up the sod with the tailskid when we taxi. Haven't had to check the safety wire on the rigging turnbuckles for a long time. You have to work at it to groundloop the modern bird. Nowadays, landing at a strange field is seldom complicated by a freshly dug badger hole or an unwanted group of corn stalks.

Our airfields have gradually evolved into luxurious landing areas, and in spite of the best efforts of us fiery stones, the fly safe people have made it pretty difficult to get into trouble on a normal landing.

If you remember the long difficult

process of evolution leading up to our present long, wide airstrips, you'll remember that they'd hardly gotten the rhinoceroses off the old 4500-foot macadam strips when someone thought up the jet. Right off the bat Uncle's bill for barbed wire fence and corn fields off the far end of the runway elicited screams of rage from the economy-wise comptroller.

It didn't take long to decide we'd better do our touching down near the front end of the strip, but a few months of this operation and the man came around with the suggestion that since we were now ruining the farmers corn on both ends of the field, he would buy us some more acres so we could stretch that 4500 feet of macadam to 10,000.

"One hundred per cent spare runway ought to take care of anybody," my colleagues commented.

Alas. By the time we got our new runway, some joker came along with a bigger, hotter machine that gobbles up the runway faster than the visiting brother-in-law sops up your rare old Scotch. So, here we are again, paying for more fences and corn fields.

What Makes a Landing

Down at the far end, the barrier looks like a good answer, but how about these carom shots off the rocks short of this end of the field?

Whether we admit it or not we make occasional landings we'd rather not talk about; those landings where nothing quite clicks when you're jockeying for position all the way to touchdown. I find these harder to remember when talk turns to flying than the ones where the whole pattern feels good and you know you've got it made all the way through the landing act.

But, once in a while, when you're sliding down the groove and that warm, "this is one of those good ones," feeling comes over you, suddenly the bottom falls out and you're scrambling around the cockpit looking for a lot of power in a hurry. Or, almost as bad, you had it made for a perfect touchdown on the numbers, only the bird has other ideas and flies clear past the first intersection before it gives up.

"What gives? Have I lost the old touch?" I mutter as the smoke billows up from the tortured tires.

I speak with the voice of experience when I say that circumstance is a shattering experience, and I don't like to be shattered. The feeling is something like trying to pass a bogus "5 sixes" to a suspicious neighbor in a liar's dice game — even if you get away with it this time you know it's Lady Luck and not skill that deserves the credit. Maybe this explains the interest that was born sometime ago when during an investigation of an accident for possible weather factors, it turned out that a wind shift (or shear) was largely responsible. A few questions around the command disclosed quite a few people who had given the matter of wind shifts or wind shear and the landing and takeoff problem quite a lot of thought.

The more I looked into the problem the more convinced I became that the best answer to 100 per cent safe landings might be to extend the runways to 10,000 feet both ways from the touchdown point. However, I must admit that this suggestion was received with considerable coolness by everyone including my seven-year-old who pointed out with some scorn that this couldn't be done since our house was in the way.

Wind Makes the Difference

Having tried to solve the problem with amazing lack of success, it seems that the next step is to read you all in on it so you won't get caught short.

If the air were always calm, you could shoot a few landings in your favorite bird, learn how things look from "high key," "low key" and final, and go on from that day forth making every one right on the numbers. However, weather and wind being

...Change Without Notice!

what they are, every approach is a little different. Most of us, I believe, use about the same power setting and airspeed every time we come down the final. The hotter the plane and the shorter the runway the closer the final approach speed has to be to the stall speed in order to get it on the ground and stopped short of the far end of the field.

In order to use our standard approach, airspeed, rate of descent and power setting, we generally compensate for wind by moving the base leg in closer to the field. The stronger the wind, the closer the base leg (within reason). I can imagine a situation at a place like Thule where the windspeed might equal the final approach airspeed of a particular plane. That would be the "limiting case" as the mathematicians say, where, if we insisted in using our standard approach speed, rate of descent and power settings, we would have to roll out onto final directly above the touchdown point. Since our approach speed and the windspeed would be equal, our groundspeed would be zero and we would come down vertically at our normal rate of descent. As a matter of fact, I've seen a version of this sort of thing and I'm sure you have, too, around the local civil airport when occasionally a light plane can be seen hovering or actually flying backwards when there is a stiff wind blowing.

Let's just suppose that one day we have a chance to try this vertical landing operation. We know the wind is strong enough to do it from the amount of flying it took to get into position in the pattern. There we are at 1000 feet over touchdown point, indicating about 120 knots, flying into a 120-knot headwind (zero groundspeed), final approach power set and our normal rate of descent established. As we let down through say 500 feet, we pass through an inversion and discover to our horror that below the inversion there is *NO* wind blowing. With zero groundspeed and suddenly no headwind to give us flying speed, it feels like someone has cut the string and the rest of the flight resembles that of a manhole cover tossed out of a 10th floor window.

The culprit in the case is wind shear. Fortunately, such extreme shear probably doesn't exist outside of a tornado (which I'm not personally going near enough to investigate). If such shear were common, you undoubtedly could not give away real estate in the approach zone of an airport. However, it's a rare day indeed when there isn't a little wind shear kicking around.

What Is Wind Shear

If you have the wind blowing one speed and direction here and another speed or direction a short distance away, you have wind shear. You can dress up the definition a little and call the surface where the two winds going in different directions or speeds rub against each other, the zone of shear or the shear surface or shear line, but it all means the same thing. A cold or warm front is a good example of wind shear with the warm air above moving in one direction and the cold air below going in another direction.

Another good example of wind shear is the strong wind that suddenly springs up just before the afternoon thunderstorm reaches the weatherman's picnic. At one instant it is almost calm, the next it is blowing and raining like mad. The dividing line between the calm air and the wind is a wind shear line.

First, let me explain further why we should keep our eyes peeled for wind shear and then I'll give you a few hints on how and where to search it out.

Even though the extreme example of shear we dreamed up a few paragraphs back wouldn't occur, wind shear between the ground and traffic pattern altitude of 15 to 20 knots is common and a shear of 30 to 40 knots is not uncommon in some parts of the world.

In modern high wing loading planes, this situation can cause trouble. If we come down the final approach at 15 knots above stalling speed, and pass through a shear line, where our effective head wind decreases by 15 knots we are immediately at stalling speed. The only way we can prevent a stall is to sacrifice altitude for airspeed or increase airspeed by adding power. In actual practice we simultaneously drop the nose and hit the throttles and if we have enough altitude we drag it on into the field and make a landing. Should our altitude run out before the power takes hold, we land short. The more sudden and severe the decrease in head wind component and the closer to the ground it happens the more chance there is that we will stall in short of the runway.

FIG. 1

How to Spot a Wind Shear Situation

1. Look for an inversion below traffic pattern altitude. Smoke rising in one direction for a few hundred feet, then suddenly turning and taking off in another direction above that, is a sure sign. Smoke from high stacks going in a different direction than that from short ones. A flat topped haze or smoke layer also indicates an inversion. This is usually the best way to spot one of the nighttime wind shear inversions.

2. When the wind at pattern altitude is obviously stronger than that reported by the tower, you have shear . . . so be on your guard.

3. When the tower reports strong surface winds, say over 30 knots, you are apt to have a significant amount of friction-induced shear in the lower 25 to 50 feet . . . so be prepared.

4. When you see a thunderstorm approaching the field, watch out for wind shear. It's certain to be there.

The Two-Edged Sword

Wind shear is a two-edged sword. It can put a good man down in the rocks at the far end of the field too if he's too proud to go around. Suppose our particular airplane stalls at 100 knots so we've decided to fly our final approach at 115 knots. On this particular day there is no wind at traffic pattern altitude so we set up our turn onto final accordingly for the usual touchdown on the numbers. Since there is no wind at altitude, our speed over the ground and our airspeed are the same or 115 knots in this case. Just as we get down to the last 100 feet, we pass through a shear line and on the other side of it we find a 15-knot wind blowing right on the nose. Since for several seconds at least the bird keeps blundering along at the same old groundspeed of 115 knots, the 15 knots of wind on the nose adds to it and you find yourself with 130 knots of airspeed. This is pure bonus to the modern low drag airplane and it continues to fly way, way down the field before it gives up and touches down. A friend told me that an extra five knots airspeed over the boundary lights meant an extra 1000 feet of runway on a calm day. This may be a slight exaggeration, but in the absence of any conflicting story I'm inclined to believe him.

The situation begins to get even more binding when you consider the case of the bigger and hotter birds. As a result, we are refining our landing techniques. We attempt to fly very accurate final approach speeds. This could leave us wide open for the wind shear type of undershoot landing, although it's good medicine for the overshoot type.

This wind shear problem can cause a lot of consternation on takeoff too. Take for example a heavily loaded bomber. Even with maximum takeoff power, it takes several seconds for the airspeed to build up to say, 25 knots above stalling. If you run through a shear line that decreases your airspeed by 20 knots just as your wheels start up, you stand a good chance of settling back with a dull thud. The same thing can happen of course to any type of plane, but the faster it accelerates through the critical speeds near stalling, the less chance you have of getting in trouble with wind shear on takeoff. That's why the fighter types should have less worry on this score than the heavy transport and bomber jockeys, if you don't pull the fighter off before it's ready to fly.

Where to Find It

If you are convinced that wind shear can put you in an uncomfortable spot, here are some pointers on where and when to look for it.

In the first place, wherever there is a temperature inversion you nearly always have some shear. Since inversions form almost every clear night, near the ground, it stands to reason that the late night and early morning hours are a good time to be extra wary. These nighttime inversions can develop within a short time, and a wind shear of 10 to 20 knots within 100-200 feet of the ground can be expected. Semi-permanent inversions stick around places like the southern California coast, Spain and northwest Africa caused by the California and Azores high pressure areas, respectively. Those inversions are generally higher than normal traffic pattern altitude though and so don't often cause a shear problem.

The inversion caused by the Great Plains high is sometimes low enough to cause a traffic pattern wind shear problem anywhere from the Appalachians to the Rockies. However, it is along its western edge where it pushes up to the foot of the Rockies that you can find one of the most startling and perhaps dangerous displays of wind shear.

In a 50 to 150-mile wide belt in the

Continued on page 20

SIMULATED MOTION IS IT WORTH IT?

1Lt Mark F. Benda
305 AREFW, Grissom AFB

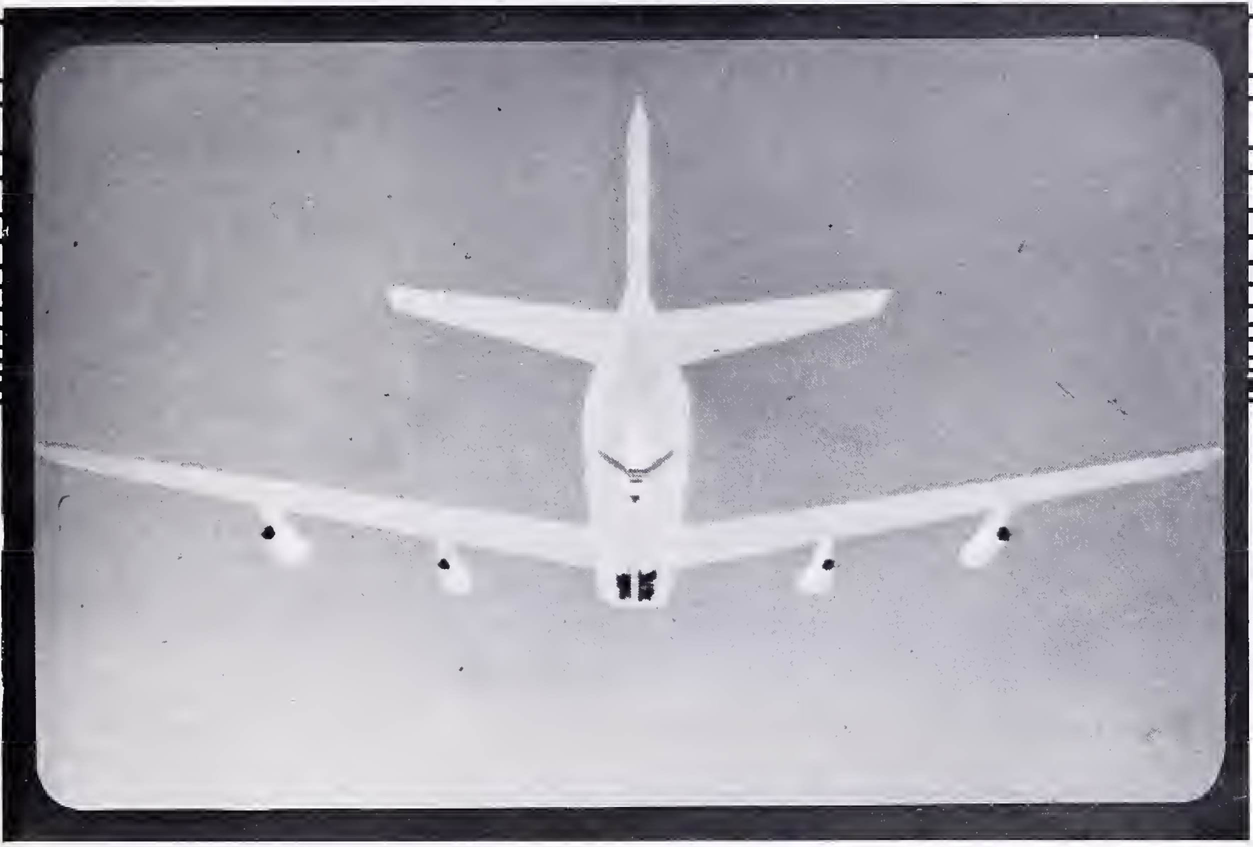
In the past, the Air Force encountered few restrictions on the amount of flying time available. Then the energy crunch appeared and to conserve fuel, the Air Force established a goal to reduce flying hours 25% by 1981. The logical answer to the question of how to maintain the proficiency of USAF pilots was to increase the number of simulator missions. The decision was made to procure the most modern and sophisticated simulator hardware that could be developed. This decision resulted in a multimillion dollar contract that would involve many types of simulators. The new generation of simulators are designed to include a computer generated visual system, but there is doubt as to whether motion is needed. The arguments are many, both for and against motion, but it comes down to whether it will be cost effective. I feel that as a pilot, having experience in simulators with and without motion, the need for motion is a great one. I will show the results of several motion studies and what alternatives to motion exist.

Now that we're in the process of procuring a simulation system, I feel we can learn much about the pros and cons of motion by discussing the idea with airline representatives. In a symposium conducted by a major airline, it was noted that they have flown 12 motion base, color visual flight simulators 16 hours per day every day for nearly 10 years. They began their comprehensive simulator program back in 1966, because their accident record on training missions was unacceptable. At that time, 30% of all airline accidents occurred during training flights. The cost of those accidents, as well as the cost of flying the actual aircraft, was many times that of their present simulator program. The simulator program of that airline was successful because of the high level of fidelity of their simulators, and the positive attitude of the airline management and its flight crews. Today, almost all of their training and upgrade programs are accomplished using the simulators and they have improved their safety record significantly. During the last 10 years, they have had no accidents or fatalities, with nearly four million takeoffs and landings. The airline was able to accomplish this by building a simulator almost exactly like the airplane, and the motion system was a big part of this.

Two of the biggest problems associated with a new and more comprehensive simulator program is first acquire the right kind of system and then convince aircrews that simulators will be more effective in training than actual flying. Several motion studies have been conducted to see if the pilots felt more assurance with a simulator that utilized motion.

It is widely accepted that onset cues of motion are more important than steady state acceleration cues. This involves the principle of motion washout where the degree of motion is gradually reduced to a point where it is not perceived at all. Motion washout can be compared to the leans, only it is the reverse. The simulator could be tipped to indicate a bank, and then while all visual cues are maintaining the bank, the simulator slowly returns to its normal upright position without disturbing the vestibular system. It has been found that motion provides the pilot immediate feedback of a condition such as turbulence or an engine failure, and shortens the lag time of response. Most studies of motion are centered around six degrees of freedom — pitch, roll, yaw, lateral, vertical, and longitudinal. Since actual flight involves all six degrees of freedom, it would be best to utilize all six degrees. However, some simulators are in service with the airlines that use fewer than six degrees of freedom.

The Langley motion study related the effects of motion to the accomplishment of various flying tasks. Six degree-of-freedom motion showed significantly better results than a fixed base or limited motion simulator. It was also determined that as task difficulty increases, the amount of acceptable time delay for response decreases. However, when relatively complete motion cues are included in the simulation, the pilot can maintain his performance for considerably longer time delays.



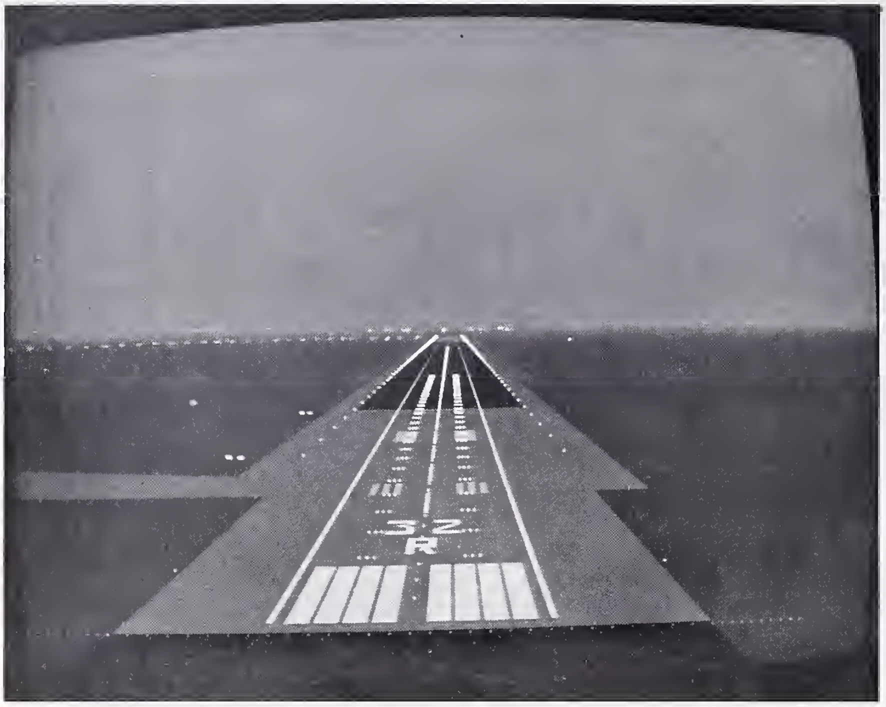
A computer generated "out the window" display.

A NASA study revealed that motion can add to the fidelity of simulation only when coupled with a reliable external visual display. It was also found that less time was required to monitor the cockpit instruments when motion was available. In addition, when a flight control input was necessary, they were less abrupt and more like those made in the actual aircraft when motion was available.

In a study done by the Conductron Corporation for United Airlines, it was pointed out that by omitting a sensory channel (motion) in the simulator, we deny the pilot the corresponding stimuli upon which he acts and also reduce the amount of feedback available by which he adjusts his response. Without the realism of motion, there is a risk of negative training transfer and reduced task validity in the accomplishment of certain maneuvers. The study showed that as the degree of task difficulty was increased, motion became a necessity to accomplish it. Simpler tasks could use visual cues of motion for their accomplishment.

In a study to show the transfer of training effectiveness from the simulator to the airplane, a reduction in the number of pilot errors, both in the simulator and the aircraft, was noted when cockpit motion with normal washout was used. The study also researched the aspect of the cost effectiveness of a motion-base simulator. The results were that the motion-based simulator transferred more training to the actual flying of the aircraft. Another item to consider in dealing with cost effectiveness is the length of the simulator mission. There is a point where the incremental transfer effectiveness ratio equals the ratio of cost of flying the simulator compared to the cost of flying the actual airplane. Use of the simulator beyond these points would be wasting the time of the student, instructor, and simulator. It also would ruin the program's cost effectiveness. The optimal length of simulator session varies with the aircraft and mission, and can be determined using the ratios. Just as an example, one airline reduced the cost of their training program from $118 million in 1966 to $55 million in 1975, just by utilizing the new generation of simulators rather than actual training flights. One hour of flight time cost them $4,399 compared to $325 for their simulator.

There are many advantages to a motion-based simulator, and it has proven to be cost effective. It also could be the only alternative for training an aircrew to handle certain emergencies. For example, various aircraft are not to be intentionally spun, and simulators are the only way to show the pilot how to recover from an unintentional spin. The KC-



A computer generated view of the runway environment.

135A has a critical emergency for failure of an outboard engine at takeoff. Since it is so critical, the procedure to handle this emergency is not practiced as it actually would happen. Our present simulators have no visual or motion capability, therefore, the simulator practice emergency may go unnoticed for a long time due to lack of cues. The Aeronautical Systems Division performed a test to evaluate aircrews in a simulator with visual and motion cues, and found the pilots were much better prepared to handle an emergency if they had the benefit of motion.

Motion has proven its effectiveness in the proposed simulators, and there are several other technological advances that could complement the system. The proposal of adding a g-suit/g-seat to some of our simulators is a good one. Many of the cockpit displacement cues available in flight cannot be duplicated in ground-based simulators. Even though sustained accelerations cannot be reproduced, the g-suit and g-seat are helpful in providing cues. Pressure changes at the pilot/seat interface normally occur in all maneuvers. It was found that these pressure changes stimulate the pilot's response more rapidly than the cues to the vestibular system. The g-suit inflates with positive g-loads, while the g-seat deflates. Under negative or zero g-loading, the g-suit is deflated and the g-seat is inflated. It was found that the best systems of simulation contained vestibular cues, pressure (g-loading) cues, and a well coordinated visual system.

With the continued emphasis on reducing costly flying hours and our present simulators built on a mid-fifties technology, the Air Force needs high fidelity cost-effective simulators to maintain aircrew proficiency at sufficient levels to safely accomplish our mission. Since motion cannot be perfectly simulated, the study is now centered on which type of motion cueing the body best perceives. The latest data would seem to suggest that the g-seat/g-suit systems give the quickest stimuli to the pilot. However, the g-seat/g-suit wuld not be as effective in larger multiengine aircraft that rarely pull g's. These aircraft, such as the B-52 and KC-135, are more concerned with critical procedures that involve yaw. It would seem that the Air Force would select a six degree-of-freedom motion simulator, similar to what the airlines are using, for its larger aircraft. In contrast, the fighter/trainer aircraft would probably have limited motion with a g-seat/g-suit system.

In a look at what lies ahead for USAF simulators, it must be pointed out that they have increasing importance in aircraft accident investigation. Simulators are used, to varying degrees, in just abut every accident investigation. The closer we get to 100%, perfect simulation, the better information the simulators will provide to determine causes of accidents. In response to pilots who dread the loss of flying time and the shift in emphasis to simulators, there is encouraging news. There are cases where accident investigation boards would probably have placed the cause of an accident on the pilot had it not been for the information gained from the simulator.

The simulator of tomorrow will be very complex. Today the Air Force has tactical simulators that can be programmed to practice air-to-air combat, aerial refueling, and air-to-ground weapon delivery. In the future, Strategic Air Command may have simulator systems which will permit a KC-135 crew and a B-52 crew to fly simulated missions as integral crews and to practice both normal and emergency procedures in a realistic environment. With few exceptions, previous simulators were for pilots only, but new systems will have independent simulator positions for each crewmember. They can be isolated or run in an integrated mode. Simulators will become so realistic that regulations will undoubtedly permit large portions of annual flight checks to be completed in the simulator. It is reasonable to expect a further reduction in flight time in an ongoing effort for conservation of resources. I feel the only safe way to do this is with an all-out effort toward 100%, perfect simulation.

THE 135
FSO PROGRAM

Major General Kelly H. Burke
Deputy Chief of Staff, Plans

For the past several months the SAC staff has been working on a programming plan that, if implemented, would (1) modify KC-135 aircraft with a dual inertial navigation system (INS) and doppler velocity sensor, (2) phase out the KC-135 navigator crew position and (3) phase in an enlisted Flight Systems Operator (FSO) crew position. Even though the plan is still in the review process and is contingent on funding for the avionics modification, we at HQ SAC believe our combat crew force should be kept advised of any plans which might affect them. Hence, let me tell you about the FSO program, specifically its background, status, and provisions and how I view its possible impact on the SAC tanker crew force.

The genesis of the FSO program can be found in SAC's continuing efforts to modernize the navigation equipment on board our tanker fleet. The present KC-135 navigation equipment, which reflects early 1950 technology, has been experiencing declining reliability while peacetime and EWO navigation requirements have been becoming more stringent. Thus in 1974, SAC submitted a required operational capability (ROC) for an INS integrated with an improved doppler. This ROC was validated by the Air Staff and funds were approved for a single INS/doppler modification for the entire Air Force -135 fleet.

With a single INS modification thus assured, CINCSAC, in 1976, directed HQ SAC/DOT to conduct tests to determine if the expanded capabilities and increased reliability of a dual INS equipped KC-135 would warrant a change in crew structure. HQ SAC first tested a pilot, copilot, boom operator crew structure. This crew complement proved unfeasible as the addition of navigation tasks to pilot duties overtasked the pilots during critical phases of flight. HQ SAC next tested a pilot, copilot, flight systems operator, boom operator crew structure. This crew structure proved feasible as flight tests confirmed that with a modern INS and the assistance of an experienced and specially trained airman, the pilots could assume responsibility for navigation of the KC-135. CINCSAC consequently tasked the SAC staff to develop a programming plan to implement the FSO program in SAC and ARF KC-135 units.

The FSO program is currently being reviewed by the Air Staff prior to submission to the Chief of Staff Air Force for approval. If approved, implementation would still be contingent on Congressional approval of funding for a dual INS/doppler modification to the entire Air Force -135 series fleet.

Several provisions in the plan may be of special interest to tanker aircrew members. First, the phase-in of FSOs will likely take four or five years and possibly more to complete. A lengthy phase-in period is programmed to insure an orderly transition both from an operations and personnel viewpoint. Second, only experienced and well trained airmen will fill FSO positions. Programmed standards for FSO applicants are high and those selected must successfully complete a special FSO lead in course at Mather AFB (ATC). In addition, selectees must also complete combat crew training at Castle AFB. Third, the FSO program requires staff navigators to manage and support the program. Navigator positions in unit DOTO, DOTN, tanker task force shops, etc., will remain and a mix of navigators and FSOs in tactical units, 1CEVG and CCTS is programmed.

Although the FSO program specifically affects our tanker crew force, I view it as part of the continuing Air Force and SAC force modernization program designed to take advantage of advanced technology. The application of technology, such as inertial navigation systems, invariably presents challenges and opportunities. For the tanker navigator, the challenge may be navigating new and more advanced weapon systems or manning responsible staff positions. For our enlisted force, the challenge may be filling a new and demanding FSO crew position. Although programming plans must often deal with uncertainties, one item remains certain. Opportunities for full and satisfying Air Force careers for KC-135 crew members will not be limited by the FSO program. Indeed, the talents of SAC crew members will always be in demand and their experience viewed as SAC's most important resource.★★

A.C.E.

Editor's Note. Copilots at 10 SAC bases will see more time in the cockpit beginning October 1 through the Accelerated Copilot Enrichment (ACE) program. Bases that will receive T-38 and T-37 aircraft for ACE use will be Pease, Plattsburgh, Loring, Griffiss, Grissom, Beale, Fairchild, Wurtsmith, K. I. Sawyer and Castle.

These bases will receive from three to seven T-37s or T-38s and the aircraft will be supported by Air Training Command personnel. The October additions complete the ACE program at all SAC aircraft bases and tenant SAC flying wings.

ACE was initiated in October 1975 as a test at Barksdale AFB. The following article deals with the program that started at Rickenbacker AFB in October 1976.

Captain Ralph L. Swann
Captain Roger G. Raper
Rickenbacker AFB

On a typical day at Rickenbacker AFB:

LEO 01: Rick tower, this is LEO 01, a T-38 eight miles out on VFR straight-in, requesting touch-and-go.

TOWER: Roger LEO 01. Flash your landing light.

(Brief Pause)

LEO 01, tower has you in sight. Be advised you are number 2 to follow a KC-135 on base for a full stop landing.

LEO 01: Rick Tower, LEO 01 has the KC-135 in sight.

(Another brief pause)

Tower, LEO 01 is breaking out for wake turbulence. Request to re-enter the pattern for another VFR straight-in.

TOWER: LEO 01, report established on a wide downwind. Traffic is a KC-135 on downwind about to turn base, another KC-135 on downwind in a right 360, and two A-7s on ninety to initial.

LEO 01: (Something unprintable spoken over aircraft intercom.)

Who was this T-38 pilot and why was he trying so persistently to wedge his aircraft into Rickenbacker's traffic pattern? The answer may be surprising. The pilot of LEO 01 was one of Rickenbacker's SAC copilots. On this particular day, in addition to his normal training, the SAC copilot was

receiving unexpected, but valuable, experience in dealing with sequencing and wake turbulence problems associated with Rickenbacker's traffic pattern. Since October 2, 1976, Rickenbacker's SAC copilots have been slipping the surly bonds in their sleek T-38 air machines as part of the SAC ACE program.

The ACE program is now a reality at many SAC bases. This program is designed to provide an environment in which SAC copilots can refine their decision making capabilities and flying skills. Thus, many SAC copilots are now spending many hours of what used to be "off-duty time," flying ATC T-37 or T-38 aircraft. These aircraft, and the ATC instructor pilots sent TDY to SAC bases, form the framework of the ACE program. Knowing what the ACE program is and what it is designed to do might lead one to ask, "Why is it necessary?"

Although there are numerous reasons for the existence of the ACE program, certain facts are very clear concerning the UPT graduate who becomes a SAC copilot. From the moment the SAC copilot began his flight training, he has been under direct, constant supervision. First by his ATC instructor pilot and then by the constant presence of SAC aircraft commanders and instructor pilots — the copilot has been watched. Thus, little opportunity for developing and demonstrating independent judgement and decision making abilities has been the rule rather than the exception. But this is only part of the problem.

Today's SAC copilot must contend with a flight time environment curtailed by the energy crisis and rising fuel costs. He must now compete with many other rated personnel who are trying to complete their flying requirements on fewer and sometimes shorter aircraft sorties. The point is more clear than ever before: the SAC copilot is fighting an uphill battle to develop his professional flying skills. The ACE program with its relatively economical aircraft systems appears to provide the solution to the dilemma.

Probably for the first time as a fully qualified Air Force pilot, the SAC copilot flying the T-38 or T-37 is given the responsibility and decision making power of an aircraft commander. The ultimate responsibility for the safe and productive completion of the mission rests with him. In an environment of reduced flying time and increased supervision of flying activities the opportunity for first-hand command experience assumes even greater importance. And, in the opinion of the ATC instructor pilots in charge of local ACE programs, the SAC copilots are responding admirably to their new-found opportunities.

SAC's ACE copilots grasp proficiency of flying the T-37 or T-38 aircraft much sooner and with less instruction than UPT students. This ability is primarily the result of a more solid background of flight experience. The ACE pilot is much less concerned with the pressures of learning to fly and the pressures of UPT graduation are non-existent. This ultimately creates a much more relaxed and profitable learning environment for him to concentrate on refining and polishing his flying

The 32 AREFS's newest copilot, 2Lt Chris Budinsky, and ATC instructor pilot, Capt Larry Gosnell, prepare to start engines during one of Lt Budinsky's four initial checkout flights.

skills. But even though the basic flying is easier, the ACE pilot is confronted with new pressures.

Every ACE pilot is forced to become much more independent and self-reliant. Where he once could rely on that other pilot in the other seat, he now must rely solely on his own knowledge and judgement. More than ever, he must study and learn general flying regulations and associated flying directives. As the pilot-in-command, he is responsible for operating the aircraft according to the rules. The ACE program provides plenty of opportunity to put this knowledge to use during cross-country and out-and-back flights.

Cross-country and out-and-back flights allow the ACE pilot to escape the local initial approach fix and fly into many different non-SAC airfields. This presents a golden opportunity to study, brief, and practice strange airfield procedures. Although most SAC pilots can brief and accomplish the home-base instrument approaches from memory, the fact remains that much difficulty is often experienced on those rare flights into strange airfields.

The ACE pilot not only has the opportunity to improve his individual expertise with strange field procedures, but he also gains new experience which helps him contribute more readily to the proficiency and safety of the crew in his primary aircraft. Since many aircraft accidents occur while crews are in strange airfield environments, the cross-country experience afforded SAC copilots may well reap great dividends for SAC in the future.

Closely related to the increased responsibility and independence for the ACE copilot has come a new feeling of self-confidence and pride. As many ACE pilots point out, "It is self-gratifying to be in a position of increased responsibility." Many ACE pilots feel that this program offers an outlet for frustrations and the desire to independently perform and excel. Equally important is the opportunity to fly just to get some "stick time." This, in part, seems to compensate for the limited training time in the primary aircraft. SAC aircraft commanders, instructors, pilots, and staff personnel have noticed that the pilots' heightened self-confidence and sense of accomplishment in the ACE aircraft have carried over into the flight operations of his primary aircraft.

Up to this point it probably sounds as if the ACE program is the greatest thing that ever happened to the SAC copilot and the Air Force. Though the ACE program offers many advantages and benefits. many ACE pilots are quick to point out that the ACE program is a "carrot-on-a-stick." The program allows them to enhance their professional flying abilities, but it also requires them to adjust to new and much tighter scheduling.

The ACE program is not all fun and thrills, nor is it just one joy ride after another. The program makes large demands on the ACE pilot's time. In addition to his primary aircraft flight duties, ground training requirements, alert schedule, and squadron additional duties, ACE pilots must also complete studying, training, and flying requirements associated with the ACE program. This often results in the sacrifice of personal plans and "off-duty time" in order to fly the T-37 or T-38. Such a full schedule creates a scheduler's nightmare, but that isn't the only problem.

A full schedule of activities combined with adverse winter weather conditions have made completion of the initial checkout flights very difficult at some SAC bases. To solve the problem of maximizing utilization of ACE program flying hours and efficient scheduling of copilot training, SAC units have had to designate personnel for ACE program scheduling duties. Although there is no authorized manning position for an ACE program scheduler, making up a workable schedule which puts the least burden on everyone concerned is a full-time task.

The SAC copilot's participation in the ACE program affects more than just his own duty schedule. To allow for the copilot's participation in the ACE program, SAC crews are finding that planning times must be carefully scheduled and varied to comply with the minimum planning hours required by SACR 50-12. Crews may have to be scheduled for Saturday mission planning because the copilots' ACE program flights preclude sufficient mission planning time on a week day. Thus, the copilot's fellow crewmembers feel the effects of the ACE program on their own schedules.

Being dual qualified presents special problems in itself. Dual aircraft qualification requires systems study, procedural knowledge, and flight proficiency in two dissimilar aircraft. The ACE pilot must strive to achieve a proper balance between the requirements of the two aircraft systems. The copilot may often find it difficult to recognize that his primary duty is maintaining effectiveness as a SAC crewmember. Several consecutive days of ACE flying interspersed with only an occasional flight in his primary SAC aircraft can easily lead to overemphasized study for the ACE program and underemphasized SAC duties. To offset this effect the copilot must constantly work at maintaining proper perspectives toward his primary job.

During the initial implementation of the ACE program, the dissimilar flight characteristics of the two aircraft types resulted in some unfavorable trends during the landing phase. The different glide paths and aim points of the two aircraft brought a tendency to "tuck-under" or land short when flying the heavier SAC aircraft. Dissimilar landing characteristics and crosswind landing procedures have necessitated special emphasis on proper landing techniques in each particular aircraft. The ACE pilot's awareness of the problems combined with greater experience flying dissimilar aircraft have proven to be a key solution.

Although other problems could possibly be cited concerning dual qualification, the problems presented thus far are sufficient to point out some inherent difficulties of having dual qualified copilots. However, the problems of the ACE program must not be allowed to overshadow the positive aspects. Only when the ACE program has operated sufficiently long enough to be objectively evaluated should it be put on the block for evaluation. If in the long run a SAC copilot improves his flying skills, increases his crew coordination, and ultimately becomes a better aircraft commander as a result of his ACE experience, then SAC will have gained a lot for a very low cost.

SURVIVAL ON THE WAY TO ALERT

1Lt Robert J. Tormey
509 SMW, Whiteman AFB

"Lee's Summit, this is HPD 70. We need the coroner. Highway 18, east of Adrian."

"Breaker, breaker 19, notify Johnson County Hospital that crash victims are enroute, need emergency treatment."

Although these are two separate incidents, they both have a common element: missile combat crewmembers were involved. In both cases, the crewmembers were fortunate — they were not the victims.

The first case I know all too well. We were on our way to alert. It was late at night, the road was narrow, winding, and slick from intermittent thundershowers. As we approached a familiar bridge, we noticed that an automobile had struck the bridge abutment and the driver was thrown onto the roadway. Our crew was the first to arrive on the scene. There was a definite smell of liquor and gasoline in the air.

Our first reaction was to help the driver, but it was too late. He was dead. A search of the rain-soaked underbrush revealed no other victims. The driver had been alone. Since the car was completely blocking the highway, it was essential to alert approaching traffic of the danger ahead. We used the triangular safety shields stored in the crew vehicle to accomplish this, and this action proved more important than we realized. The driver of an oncoming

vehicle later told us that due to the darkness and isolated location, he could not have stopped in time had it not been for spotting the reflective shields.

In my mind there are three important safety elements in the above sequence. "Don't drink and drive." An overused phrase perhaps, but one that evokes some vivid images when associated with someone's guts spread over the highway. If you come upon an accident, consider what actions must be taken to insure other drivers are made aware of the danger. We were lucky that we had good signaling devices. If we hadn't, we would have had to devise some other means of alerting approaching drivers. The obvious cannot be overlooked either; crewmembers on their way to alert duty, or anyone who operates a motor vehicle, must drive within the limits imposed by weather and hazardous road conditions. It's common sense, right?

Road and weather conditions were also contributing factors in the second accident case. Again, a crew was on their way to alert. This time the weather was below freezing and the roads were extremely icy. The crew arrived at an accident scene to find a car overturned on the side of the road. The driver was staggering around while his wife lay on the ground. A truck driver had put a coat over her to protect her from the freezing drizzle, but he was unable to render any further assistance. Due to the accident location and the transportable condition of the victim, the crew placed them in the crew vehicle and took them to the nearest hospital.

Here at Whiteman some of the launch control facilities are located a hundred miles from the base. Crews at other Minuteman bases are not so "lucky." In some cases, sites are accessible only by country roads over 150 miles from the support base. With crews traveling these distances sometimes four or five times a month, the weather and road conditions become as important as the condition of the vehicles we drive, and winter weather only compounds the problem. While you may be sick and tired of being reminded to "buckle up and drive safe," just remember, if you are involved in an accident, it's better to assist the victim than to be one.

Sandia Laboratories

THERMAL/FLASHBLINDNESS PROTECTION

SAC AERONAUTICAL SYSTEMS

Aircrews of the 22/380 BMWs and 452 AREFW are currently performing an Initial Operational Test and Evaluation (IOT&E) of a new thermal/flashblindness goggle in B-52, KC-135 and FB-111 aircraft. This device is a state-of-the-art development engineered by the Air Force Systems Command, Aeronautical System Division and Sandia Laboratories in response to SAC ROC 25-69. If approved, this device will replace the gold goggle and monocular eyeshield requirements and will offer a drastically improved thermal/flashblindness protection system for aircrews.

The system consists of a transparent electro-optical ceramic called PLZT (from the chemical symbols for lead, lanthanum, zirconium, titanate) and two crossed polarizers. This PLZT material, when placed between the polarizers and connected to a low voltage source (28VDC), will rotate the linearly polarized light that is transmitted through the first polarizer so that it passes through the second polarizer. The system contains two sensors that, upon detecting a nuclear flash, will reduce the voltage and within microseconds, the system will transient to an opaque (protective) state of operation. As thc light intensity of the flash gradually diminishes, the voltage increases so that the light transmitted through the system is restored to the level which existed prior to the flash. Since the crewmember's vision is never completely blocked, he always retains some external visual capability which allows for continued performance of flight duties. The transmittance value of the system during the open (non-protective) state of operation is approximately 20 percent as compared to 15 percent offered by standard sunglasses. The goggle is compatible with the HGU-26/P helmet equipped with the PRU-36/P dual visor assembly and the MBU-5/P oxygen mask. A non-helmet mounted goggle version is under development and will be tested at a later date in KC-135 aircraft.

The purpose of this IOT&E is to determine the operational suitability, maintainability and effectiveness of the goggle system and to assess final configuration for helmet/oxygen mask compatibility, assembly design, aircrew comfort, visibility and ease of donning/doffing. The test will be conducted over a two month period during normal operational training flights and will consist of day/night observations during simulated alert response, taxi, takeoff, cruise, air refueling, low level, weapons delivery, approach and landing phases of the mission. All aircrew positions except B-52 navigators, radar navigators, and electronic warfare officers will evaluate the goggles. Additionally, aircrew life support technicians will evaluate helmet modification procedures, goggle maintainability and technical data standards.

Further development and technology advancements with PLZT application continues. Thermal shield segments have been designed and developed for other aircraft application. This system utilizes a porthole design (approximately 6″ diameter) that is attached to rigid thermal shields; however, the principle of operation is the same as that for the aircrew goggle. The primary advantages purported to be offered by this system is that the protection device is intergrated into the aircraft as a subsystem and not attached to the crewmember's facial area. In addition to providing both thermal and flash protection as a single entity, this system design eliminates the numerous maintainability problems inherent with fabric thermal curtains. The rigid thermal shield/PLZT segment design is presently under consideration for other USAF aircraft having a thermal/flashblindness protection requirement.

The feedback we have received from the selected crewmembers participating in this IOT&E has been very favorable and constructive. Although the added weight to the facial area appears to be the biggest complaint factor, its operation continues to amaze and receive outstanding comments from all. Once the goggles are operational and you have had the opportunity to observe its operation, you too will be just as pleased and consider the PLZT device as a great technological advancement over the present thermal/flashblindness protective system we have today.

Change Without Notice!

Continued from page 7

flatlands east of the Rocky Mountains extending all the way from Fairbanks, Alaska to El Paso, Texas, blows the famed Chinook wind. Shear-wise, the Chinook causes its trouble when it is trying to move in, and the effect is most pronounced when there is a cold high pressure cell spread out over the plains and pushing up against the foot of the Rockies.

Chinooks occur on the eastern slopes of the Rockies at places like Peterson Field. The low level jet is prevalent in the Great Plains, at places like Dyess and Ellsworth. Chinooks are a winter problem; low level jets can be encountered during any season and are usually associated with strong early morning inversions.

What happens is this. The warm, dry Chinook wind comes booming down over the Continental Divide from the west toward Fairbanks or Malmstrom or Amarillo, where a layer of cold air is covering the area like a tent. The Chinook, being warm, naturally slides over the top of the cold air and right there you have a very respectable shear surface established. As it continues to blow, gradually pushing the cold air back, the inversion (shear line) works its way down toward the surface. Eventually at pattern altitudes and lower you find a westerly wind of as much as 40 knots, while at the surface the wind is nearly calm.

If you happen to make a landing about the time the inversion has worked itself down to within a hundred feet or so of the ground, you can see that you might well be in for some excitement.

Another wind shear situation exists when there is a strong surface wind. Moving rapidly over trees, rocks and buildings, the wind closest to the ground is slowed down so that from 25 to 50 feet above the surface and on up the wind is blowing faster than it is at the surface. This friction induced wind shear *always* tends to make you land short. However, its effect is usually small and since it is only present with fairly strong surface winds when you can afford to shoot for a spot 1000 feet or so down the runway, it is not a serious hazard, provided you remember that it does occur, and you should make allowance for it.

The one other major wind shear producer is the thunderstorm. Flying cross-country on a summer afternoon you've probably seen a cloud of dust marching along just ahead of the storm. When you are sitting on the ground you know how deathly calm it gets before a thunderstorm, then all at once the wind and rain hit. That's the thunderstorm's most severe shear line. About the only useful advice I can offer is "Don't take off or land into the teeth of an approaching thunderstorm." It's better to wait until the storm center passes over the field.

That's the general picture on what sort of situations produce wind shear lines and some of the reasons why this is becoming more of a problem than it has been before. Since it is a problem, it is important to be able to recognize a wind shear situation when you see one. (See Figure 1.)

What Was Being Done About It Then?

Frankly, at the present time there is no practical way to measure wind shear above an airfield. Since we cannot measure it, it follows that the tower is unable to warn you of its existence when you call in for landing instructions. A wind shear situation can change almost as rapidly as ceiling and visibility. It follows that to be of much practical value, wind shear conditions would have to be measured at reasonable frequent intervals. Once an hour might be frequent enough but no technique we have available seems to be practical for measurements that often. Various kite or captive balloon combinations have been considered but there are those among us, including myself, who would rather fly through a wind shear than a string of kites and balloons. There are undoubtedly other ways to measure the phenomena and perhaps one of you has an idea that will work. If you do, let us hear from you.

What is Being Done About It Now?

Air Weather Service plans to begin a special wind shear advisory program this year. Forecasting techniques have been identified, and forecasters will be trained to use them. Wind shear advisories will soon become a standard part of the local meteorological watch program.

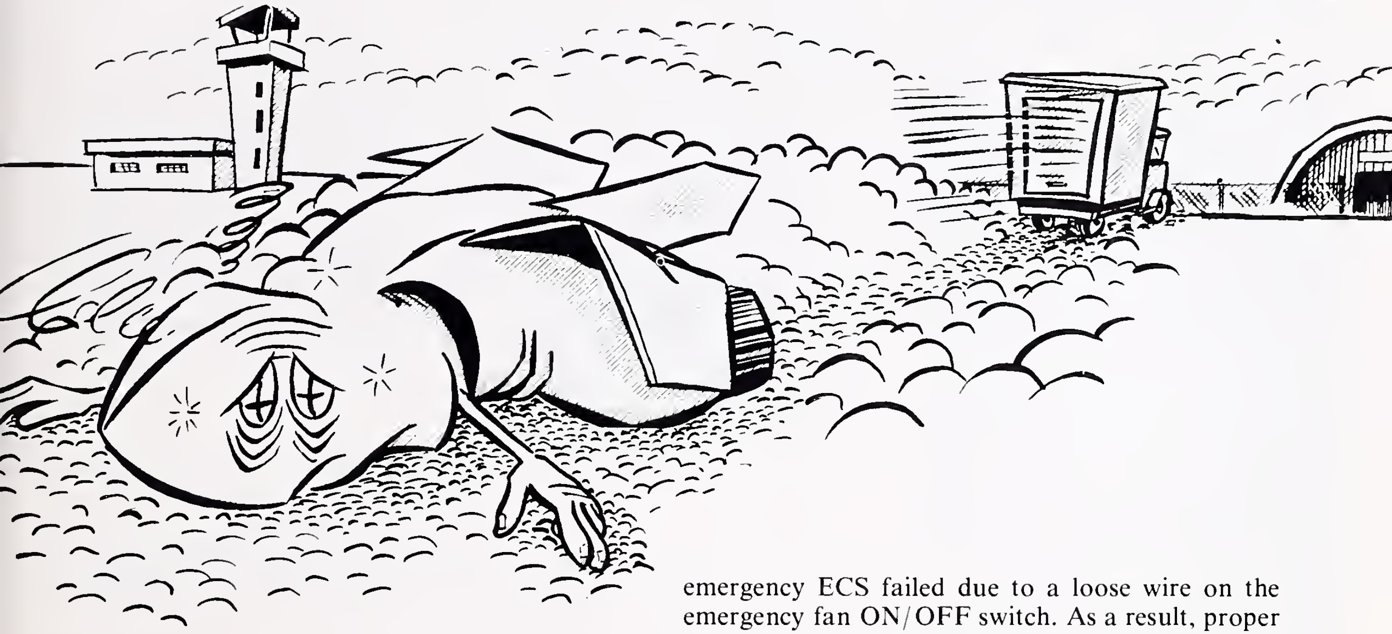
Given impetus by a multicommand Required Operational Capability, the FAA, in conjunction with AWS and the National Weather Service, is developing instruments to measure wind shear. Kites and balloons are still in the running; however, new types of radars being tested at Dulles International Airport show promise for eliminating the problem of getting wrapped up in the kite strings. One type of radar uses acoustic energy; another uses a laser source; both are capable of remotely sensing the wind structure of the lower atmosphere, and both can identify wind shear layers. In addition, the FAA is also looking at cockpit wind shear warning systems that would be triggered by sudden changes in true air speed. It may be some time before these instruments become operational, but it's encouraging that we no longer have to say, "there is no practical way of measuring wind shear."

What Can You Do?

Meanwhile, now that you know how to recognize wind shear in its native habitat, you'll find that it can be handled in a fairly straightforward manner if you spot it before it gets you in a spot.

MISSILE MISHAPS

QUAIL. An inspection revealed a damaged nose cap (radome) on a Quail missile stored in the dock. The damage was caused by an unknown object striking the nose cap with sufficient force to crush the fiberglass honeycomb surface. Tire tracks in the immediate location of the damaged missile indicate a vehicle ran into the Quail. Stanchions are now in place on the dock to prevent vehicular traffic around stored equipment. Also, personnel have been briefed to be extremely cautious and utilize spotters inside hangars and storage areas.



QUAIL. A maintenance team was dispatched to download the Quail package from the buildup fixture. The team began lowering the package to the MHU-7M trailer, but stopped when they heard a loud popping sound. A check revealed the left side launch gear electrical disconnect was still engaged. The connector was disconnected and the download was completed without further incident. Cause of the mishap was failure of the team chief to follow tech data.

MINUTEMAN. A Minuteman launch facility lost commercial power due to thunderstorm activity and the diesel failed because of low lube oil pressure indications. In addition, the emergency fan failed to start, resulting in loss of cooling air which caused overheat damage to two equipment drawers. The cause of the mishap was loss of standby power and the loss of the normal environmental control system (ECS). The emergency ECS failed due to a loose wire on the emergency fan ON/OFF switch. As a result, proper maintenance and checking for loose connections will be a high interest item during maintenance inspections conducted by field supervision personnel at this unit. How about your unit?

SRAM. A munitions load crew was mating an ADU-317/E adapter with a rotary launcher loaded with six missiles to a MHU-123/M trailer in a multicubicle magazine. The operation proceeded normally until after the crew on the near side of the trailer installed the bumper blocks and removed the towbar assembly. The towbar was then put under the trailer for storage. Meanwhile, the crew on the far side of the trailer experienced difficulty installing the bumper blocks. The crew chief directed that the far side be lowered to enable bumper block installation. As the far side was lowered, the missile struck the towbar and suffered over $3,700.00 damage. Cause: personnel error. The local procedure for storing the towbar has been changed so the towbar will not be under the trailer during the mating operation.

BIG INSTRUMENT

CIRCLE TO LAND — PART I

Capt. Lewis M. Hatch
1st Combat Evaluation Group
Barksdale AFB

This article, the first of a two-part series, emphasizes the circling approach, a maneuver that very few crewmembers practice with any regularity. Many neglect this area because they believe that there is little possibility of ever having to fly a circling approach or that a circling approach is a standard visual pattern, requiring no special techniques. There are, however, several factors that may require a crew to fly a circling approach. Some approaches and airfields, for instance, have only circling minima published. These approaches are identified by a letter following the approach type rather than a runway number (i.e., "VOR/DME or TACAN A), and usually result from final approach alignment problems. It may also become necessary to accomplish a circling approach due to traffic restrictions (Torrejon AB) or compatible approach/active runway conflicts (Altus AFB, March AFB, etc.). If it becomes necessary to fly a circling approach when the weather is at or near circling minimums, some special techniques may be required to land safely out of the approach. The remainder of this article will be devoted to a brief review of circling approaches.

Q. Isn't it true that a circling approach is just a normal VFR traffic pattern?

A. Not necessarily. A circling approach is a visual maneuver used to transition from an instrument final approach course to the landing runway. Although the ideal situation would allow a pilot to fly a normal VFR traffic pattern, this is not always possible. Many variables may require a pilot to modify his normal traffic pattern in order to land the aircraft safely. Factors that most commonly require pattern modification are final approach course alignment with the landing runway and existing weather conditions. These factors may require a pilot to fly a significantly lower and/or tighter pattern than usual. For most SAC aircraft, maneuvering at 600 feet AGL and within 2 statute miles of the runway is hardly a normal pattern, yet this may be required to execute the approach if existing weather is at circling minimums for the aircraft category.

b. Explanation of Terms — Five Approach Categories A thru E control landing minima for different types aircraft. Speeds are based on 1.3 times the stall speed in the landing configuration at maximum gross landing weight. An aircraft shall fit in only one category and that category shall be the highest category in which it meets either of the specifications. For example, a 30,000 pound landing weight aircraft with a computed speed of 130 knots fits into Category C. **If it is necessary to maneuver at speeds in excess of the upper limit of the speed range for each category, the minimum for the next higher approach category should be used.** For example, an aircraft which falls into Category A but is circling to land at a speed in excess of 91 knots should use the approach Category B when circling to land.

APPROACH CATEGORY	SPEED/WEIGHT
A	Speed less than 91 knots, weight less than 30,001 pounds.
B	Speed 91 knots or more but less than 121 knots; weight 30,001 pounds or more but less than 60,001 pounds.
C	Speed 121 knots or more but less than 141 knots; weight 60,001 pounds or more but less than 150,001 pounds.
D	Speed 141 knots or more but less than 166 knots; weight 150,001 pounds or more.
E	Speed 166 knots or more; any weight.

NOTE: Category "D" may be applied by SAC, TAC, MAC, AFCS, AFSC, USAFE and PACAF for any model of the C-135 of their command when the Gross Landing Weight permits a maneuvering speed less than 166 knots.

FIGURE 1

Q. Why and how are approach categories assigned?

A. Five approach categories, A through E (see Fig 1), are established to compensate for the different performance capabilities of various types of aircraft. These categories allow approach designers to provide adequate obstruction clearance and specify approach minimums compatible with the wide spectrum of approach performance represented in operational aircraft, without unduly restricting lighter, slower aircraft. Approach categories may normally be expected to affect visibility requirements for straight in approaches or ceiling and visibility requirements for circling approaches.

The assigned approach category for your aircraft may be found in FLIP General Planning, Chapter 9. Some aircraft flight manuals also state the approach category in the all-weather section (FB-111 and B-52). The assigned category is based on the maximum landing gross weight and an airspeed equal to 1.3 times the stall speed (Vs) in the landing configuration at that gross weight. B-52 and KC/EC/RC-135 aircraft are assigned to Category E while the FB-111 is in Category D.

Q. Then these aircraft will always shoot approaches to their assigned category minimums?

A. Not necessarily. While it is true that the B-52 will fly an approach no lower than Category E minimums and may not fly an approach unless Category E minimums are published, the situation is more complex for the FB-111 and KC/EC/RC-135.

When operating at normal landing gross weights, the FB-111 maneuvers at 160 KIAS for circling approaches and may apply Category D minimums. However, heavy gross weights or high drag configurations may require a maneuvering airspeed of 166 KIAS or more. Since FLIP General Planning states, "If it is necessary to maneuver at speeds in excess of the upper limit of the speed range for each category, the minimum for the next higher approach category should be used," the pilot would be required to apply Category E minimums (see Fig 1). FB-111 pilots should insure that they apply the appropriate category for their maneuvering speed when flying a circling approach.

KC/EC/RC-135 pilots face just the reverse situation. Although assigned to Category E, these aircraft may apply Category D minimums if their landing gross weight permits a maneuvering speed less than 166 KIAS (FLIP GP, Chapter 9). Since maneuvering is normally accomplished with flaps at 30 degrees and at 30-degree flap approach speed, the aircraft must weigh 180,000 pounds or less to apply Category D minimums (pattern/maneuvering speed less than 166 KIAS). Above 180,000 pounds gross weight, category E minimums must be applied. This gross weight is accurate for landings in 30, 40 or 50-degree flap configuration.

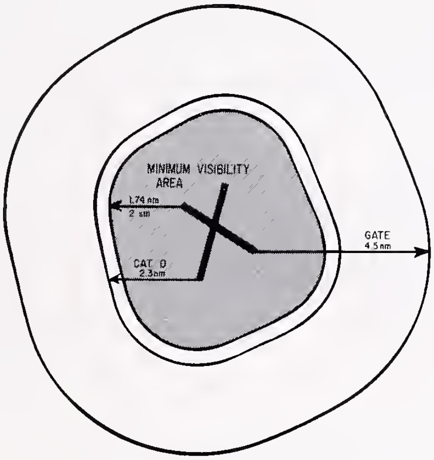


FIGURE 2 Protected Airspace

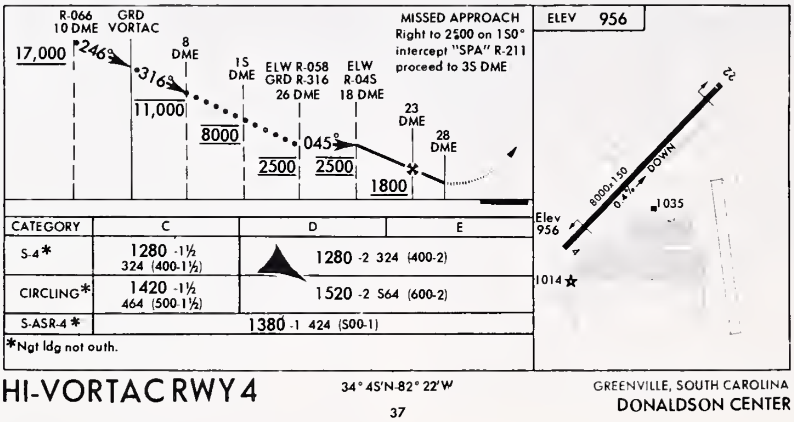
NOTE — The requirement of AFR 60-16, SAC Sup 1, requiring crews to apply a 1500 foot ceiling and 3 miles visibility for circling approaches where minimums are not published by category (non-TERPS approaches) no longer has any application. The USAF Instrument Flight Center advises that such approaches are no longer in existence and that none will be added to DoD publications in the future. Similarly, the 1.7 nm circling radius associated with non-TERPS approaches has been deleted from AFM 51-37.

Q. Why are the ceiling minimums and MDA/HAA published by category the same on some approaches, while on others they're different for each category?

A. AFM 55-9 (TERPS), which prescribes procedures used in designing approaches and determining minimums, establishes areas for obstacle clearance protection during circling approaches that increase in size with the approach category. As an example, Category D approaches are provided a circling radius of 2.3 nm, while Category E approaches are given 4.5 nm. These radii provide arcs about the end of each runway which are joined by tangential lines (see Fig 2). The entire area within this perimeter is used to determine the minimum height above airport (HAA) required for the approach. The HAA/MDA for the category must provide at least 300 feet of clearance over the highest obstructions within that area. Therefore, if an obstacle 2.0 nm from the runway is used to determine Category D minimums and a higher obstruction exists 4.0 nm from the runway, Category E minimums for the circling approach will be higher (by roughly the difference in height and elevation of the two obstacles). However, if the highest obstacle within 4.5 nm of the runway is very close to the field, all five categories may have the same minimums (although standard visibility minimums normally differ by category).

Q. Since obstacle clearance for a circling approach is determined for the entire area surrounding the airport, shouldn't the circling minimums for all approaches at an airfield be the same?

A. At some airfields, this is true. However, there are several other factors that may affect circling minimums. For example, AFM 55-9 states that circling minimums may never be less than the straight-in minimums for a given approach. Since the area considered for obstruction



CATEGORY	C	D	E
S-4*	1280-1½ 324 (400-1½)	1280-2 324 (400-2)	
CIRCLING*	1420-1½ 464 (500-1½)	1520-2 564 (600-2)	
S-ASR-4*	1380-1 424 (500-1)		

*Ngt ldg not auth.

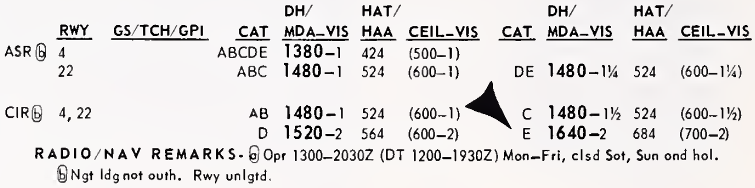
HI-VORTAC RWY 4

34°45'N-82°22'W

37

GREENVILLE, SOUTH CAROLINA
DONALDSON CENTER

FIGURE 3



	RWY	GS/TCH/GPI	CAT	DH/ MDA-VIS	HAT/ HAA	CEIL-VIS	CAT	DH/ MDA-VIS	HAT/ HAA	CEIL-VIS
ASR ⓑ	4		ABCDE	**1380**-1	424	(500-1)				
	22		ABC	**1480**-1	524	(600-1)	DE	**1480**-1¼	524	(600-1¼)
CIR ⓑ	4, 22		AB	**1480**-1	524	(600-1)	C	**1480**-1½	524	(600-1½)
			D	**1520**-2	564	(600-2)	E	**1640**-2	684	(700-2)

RADIO/NAV REMARKS- ⓐ Opr 1300-2030Z (DT 1200-1930Z) Mon-Fri, clsd Sat, Sun and hol.
ⓑ Ngt ldg not auth. Rwy unlgtd.

FIGURE 4

clearance in the final approach segment varies according to the type and location of navigation aid used, it is possible for the circling minimums of one approach to be affected by an obstacle while other approaches to the same runway (or different runways at the same field) are not affected. Obstacles occurring along missed approach routings may also dictate a higher MDA for an approach. In any case, a crew member must insure that he has selected the proper minimums for the approach.

Q. Where are the circling minimums for a published approach found?

A. Reviewing what we have already discussed concerning circling minimums will assist in answering this question. First of all, remember that as long as an aircraft is maneuvering within the protected radius provided for its category, obstruction clearance is guaranteed regardless of the runway of final landing. Obstacles requiring higher minimums will occur in the final approach segment or the missed approach segment **of the approach being flown.** Therefore, the applicable circling minimums are those published in the landing minima section of the approach plate being used.

Q. Where radar minimums are published on an approach plate, may the circling minimums on that plate be used for radar circling approaches?

A. No! While it is true that the circling minimums for the published approach are usually at or above the circling minimums for a radar approach, this is not always the case. As an example, Donaldson Center (a field many KC-135 crews have visited for aircraft modification) publishes ASR minimums on the approach procedure plate for the Hi-VORTAC Rwy 4 approach (see Fig 3). The Category D and E circling MDA published for the VORTAC approach is 1520 feet MSL. Consulting the IFR Supplement will reveal that the Category E radar circling MDA for the same runway is 1640 feet MSL (see Fig 4), 120 feet **higher.** Failure to check the IFR Supplement for radar circling minimums could result in less than required obstacle clearance being available at some point in the approach or missed approach, and could result in a spectacular end to your aviation career. Once again, the appropriate minimums will be listed according to the runway the **approach** is being flown to, not the runway of intended landing.

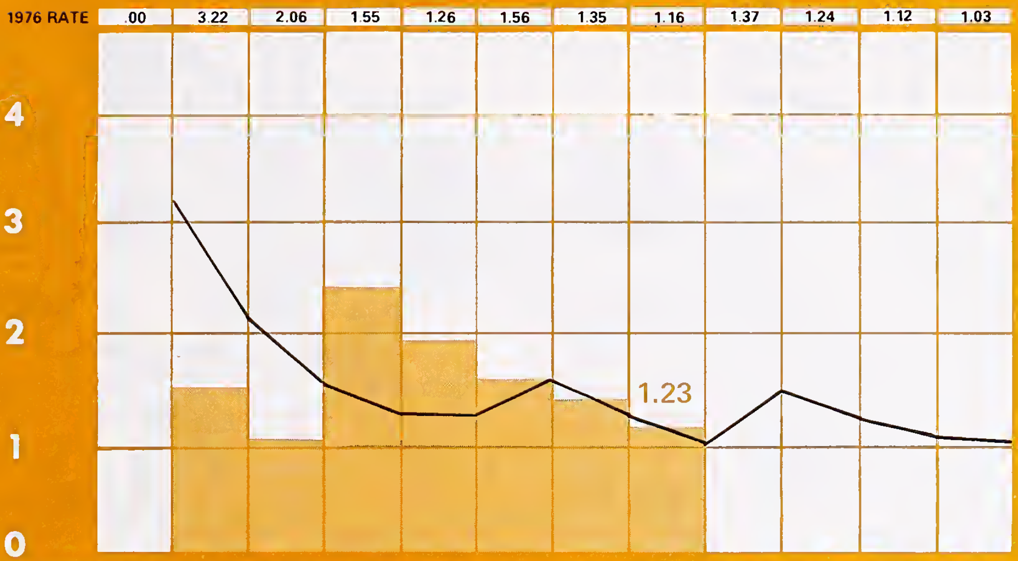
Q. Then as long as I maneuver my aircraft to remain within the protected radius for my category, I can safely and effectively fly the approach?

A. Safely, yes. Effectively, maybe. As long as you maneuver within the circling area and remain at or above the circling MDA, you will be guaranteed obstacle clearance. Under most weather conditions you will also be able to see the runway. However, the standard visibility applied to most Category D and E approaches is 2 statute miles (1.74nm). If the existing weather is right at minimums, you would have to maneuver to remain within 1.7nm of the runway to be able to land, even though you have obstacle clearance out to 2.3 or 4.5 nm (see Fig 2, the shaded area is visibility radius). Successfully flying a circling approach under these conditions requires preplanning and practice.

". . . Circle to Land . . .", Part II, will deal with circling clearances and some techniques to use when planning and flying a circling approach.

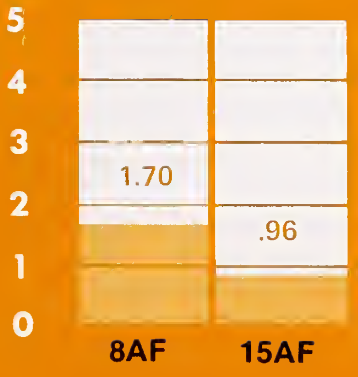
1977 Flying Safety Rate

SAC CLASS A MISHAP RATE (PER 100,000 FLYING HRS)



MISHAPS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1976	0	2	0	0	0	1	0	0	1	0	0	0
1977	0	1	0	2	0	0	0	0				

1977 SUBORDINATE CMD RATES



LEGEND ⌒ =1976 RATE

MISHAP STATUS

FB-11	FEB 77
B-52	APR 77
KC-135	APR 77

OPS HAZARDS

DON'T WORRY — The mission was a routine training mission within the local flying area which included multiple night approaches. All aspects of the mission prior to the incident were normal. On downwind leg at about 250 knots, the aircrew configured the aircraft for the fifth approach. All landing gear position indicator lamps functioned normally during the extension sequence. During turn to final at about 170 knots, the landing gear warning horn sounded. The horn was not accompanied by a red warning light in the gear handle, and the green position indicator lamps remained on. The aircrew interpreted the warning horn to be erroneous and silenced it. The warning horn again sounded on final approach with no changes in position indicator lights. The horn was silenced and the approach continued. Forward landing gear door/speed brake was in full extended position at touchdown and received extensive damage during landing roll. Investigation to date has revealed an intermittent short in the red warning light receptacle. This short most probably precluded the warning light from indicating the disagreement between the door and the commanded gear position. The speed brake malfunction was duplicated during retraction tests. The door went to the trail position only after the speed brake control valve linkages were adjusted and the slide within the control valve manually repositioned. Don't assume anything when it can be checked out in detail.

EVERY PILOT'S SECRET FEAR — Redeployment crew rest, mission planning and pre-takeoff briefings met requirements of current directives. Refueling was planned for several fighters. Nothing was unusual until the start of preflight. The aircraft commander felt the preflight was running late and asked the crew to expedite. He and the crew chief then hurried through the exterior preflight and separated in the left wheel well prior to the removal of the left main landing gear ground safety lock. While the crew chief stayed to remove the ground lock, the pilot proceeded to the aircraft interior. The crew chief failed to remove the left main landing gear ground safety lock and the aircraft commander, who had already departed the wheel well, did not fulfill his responsibility for making sure that all ground safety locks were removed.

On board, the crew did not discover that the lock was missing because the boom operator did not count and stow the locks and there was no crew assembly. Also, as part of the crew assembly, the boom operator reports to the aircraft commander "six ground safety locks stowed." This was not accomplished, however, since the crew assembly was omitted in an effort to shorten the preflight time.

The task force commander arrived at the aircraft shortly thereafter and engine start was normal. The supervisor of flying made a prelaunch check and reported the aircraft appeared ready for flight with no discrepancies. Although the ground lock was still installed in the left main gear, it is possible that the safety streamer was caught in the wheel well and out of view due to high winds. After takeoff, the left main gear failed to retract. Inspection by the onboard crewmembers revealed that the ground lock was installed and the landing gear door was open. The streamer was observed through the inspection window, but it was torn away after a few minutes of flight by wind blast in the wheel well.

The redeployment task force commander, an IP, decided to continue the redeployment flight and maintain control of the task force based on the following considerations:

- An air spare was available to refuel the scheduled fighters.

- Sufficient fuel was available to reach home station with a reserve of 40,000 pounds.

- Cruise flight could be maintained within the flight manual airspeed limits.

- If an emergency developed that caused a performance degradation, the ground lock could be removed and the gear retracted. The IP and maintenance personnel on board determined the ground lock could be removed by breaking the inspection window and releasing the gear lock with the pitot tube cover removal pole or a troop seat back support. Postflight inspection revealed damage to the wheel well panels, rib and fuselage skin. The damaged area could not be viewed in flight and was not suspected by the crew.

It appears that the air blast in the wheel well created at air speeds close to 270 KIAS combined with the length of flight time caused partial failure of the ancillary structure in the wing body fillet area.

CRACKED WINDOW — During cruise flight at 26,000 feet and 420 knots TAS, the copilot noticed a crack in his escape hatch window. The aircraft commander directed all crewmembers to don oxygen and parachutes. The aircrew requested a lower altitude and radar vectors direct to home station. The cabin pressure differential was set to 4.50 psi. The crew flew transition low approaches until reaching landing gross weight. The aircraft landed uneventfully except that during the landing ground roll the vibration caused pieces of the window to fall and land on the IP's lap. No one was injured and no rapid decompression occurred. Quick and accurate evaluation of a serious hazard and positive action prevented a much more serious consequence.

PROFESSIONAL PERFORMERS

Individuals selected for these pages as SAC's top professional performers of the month are chosen from nominations made by all SAC units. Selection is made only after all nominations have been carefully screened and those chosen meet the highest standards of excellence outlined in SACR 127-2.

FLYING CREW OF THE MONTH — During departure, as the FB-111 wing sweep was changed from 16 to 26 degrees, the aircrew noted a moderate vibration on the left side of the aircraft. All cockpit indications remained normal; however, the vibrations became more severe as the airspeed increased. Airspeed was decreased and aircraft controlability and stability were checked and insured. A hotel conference was then initiated. Following maintenance instructions, the aircraft was configured through numerous wing sweep changes, power settings and light stress maneuvers to pin-point the exact location, severity and cause of the vibration.

While these actions were being accomplished, effective coordination and communication was maintained with all necessary controlling agencies. Required checklists were accomplished simultaneously in a smooth and efficient manner. After thorough troubleshooting, the cause was still undetermined. By this time, coordination between numbered air force, aircraft technical representatives and the command post was completed. After the details of the landing were planned the gross weight was reduced and an uneventful landing was accomplished.

Postflight inspection by maintenance personnel revealed the entire left overwing fairing was attached to the aircraft only by its forward hinges. The required cable attachment, which allows this large panel to free-float during wing sweep, was missing. As a result, the fairing was held down only by the aircraft slipstream, and was forced up each time the wing sweep was changed. Any negative "g" maneuvers could have caused an extremely serious situation.

As a direct result of the ability of Crew R-37 to coordinate and communicate effectively with several agencies while accomplishing flight procedures in an emergency situation, a more serious situation was prevented.

509 BMW, Pease AFB, Crew R-37: Captain John T. Minton, pilot; Captain Norman J. Baumann, navigator.

TITAN Crew R-040, 390 SMW, Davis-Monthan AFB: MCCC 1Lt Ronne G. Mercer, DMCCC 2Lt Danny E. Rachel, BMAT SrA Bruce Nazarovich, BMFT A1C Jeffrey M. Lewis.

Maintenance Man. Staff Sergeant Philip R. Knaack, 379 Avionics Maintenance Squadron, Wurtsmith AFB.

MINUTEMAN Crew S-234, 90 SMW, F. E. Warren AFB: MCCC Captain David L. Olson, and DMCCC 1Lt Lonnie R. Mouser.

CINCSAC COMMENTS

Continued from page 3

Ground accidents, and the resultant loss of life and equipment, are of paramount concern to all of us. One problem that seems difficult to solve is seat belt usage. I just can't understand people who get uptight about using seat belts in their cars. It is an official statistic that seat belts are life savers. Certainly there are examples where seat belts did not save lives, such as head-on collisions with combined closing speeds of 140 mph. But we would have even more fatalities and more severe injuries without seat belts.

Our resources are more limited today than in the past, which simply means that we have to do the same job with fewer resources. But we're better organized now, and our equipment is better. People are the critical difference, however, and it's going to take everyone's time and energy to become more effective in day-to-day mission readiness while being sensitive to our safety programs.

We're in a different kind of business. A military career is at times inherently dangerous. Regardless of what kind of job you have, SAC is dealing with highly complex equipment and a constantly changing personnel structure while operating in many areas of the world under demanding and different environments.

I am proud of the professionals that we have in SAC and throughout today's Air Force. Most of our people understand that we're not on an 8-hour-a-day, 5-day-a-week schedule; we're a professional 24 hours a day force that places prime emphasis on the deterrent mission.

Safety to me means awareness and involvement on the part of everyone. Some may think safety has a restrictive connotation, but this is wrong. Safety's purpose is not to prohibit, but to accomplish the mission with a minimum loss of resources.

To me, safety is a personal thing. It is a measure of our collective individual intelligence and maturity. We must understand our responsibilities to ourselves and our fellow workers. There is no room for complacency. The Air Force is a demanding profession. If we can't treat our profession with respect, we should not be in it.

I would like to make one final point. Safety requires personal involvement, and our commanders and supervisors must lead the force in day to day involvement in an awareness of safety. An organization's attitude toward safety is a direct reflection of the level of professionalism world-wide. I know that your attitudes toward safety are, and will continue to be, personal, positive, and consistent.★★★★

JOHNNY RINGO

Major Lester L. Walker
341 SMW, Malmstrom AFB

Look at your hands and count the number of rings. You might take a quick survey of the people you know or work with to determine just how many people wear rings. You will probably find that nearly all of us wear at least a ring or two.

Most rings are small, round bands — generally worn on fingers. Nearly all rings are made of gold or other precious metals. Rings may be plain, engraved, decorated, or set with stones. The most popular precious stone, as you might guess, is the diamond. But the amethyst, turquoise, topaz, pearl, emerald, ruby, and sapphire are widely used. A very popular ring among Air Force personnel is called a signet ring which contains a seal — usually a school or fraternal seal.

History tells us that some people have worn rings in the nose or ear. Rings still adorn noses, ears, arms, ankles, and toes of tribal members in various parts of the world. Until the 1300's, people commonly wore rings on their thumbs. The Romans probably began the use of engagement and wedding rings. Most married persons wear the wedding ring on the third finger of the left hand because of an old, but false belief, that a vein runs directly from this finger to the heart. It is this metallic wedding band that causes most ring-related accidents.

For years and years, crewmembers have been warned of the hazards of wearing rings. The procedure has been, and still is, to remove or safety tape all rings prior to entry intc the aircraft or missile silo. In addition, crewmembers are instructed to remove rings prior to trouble-shooting electrical equipment. However, how many of us take this precaution when we become backyard mechanics?

In one mishap, while removing an oil filter, a backyard mechanic's ring contacted the 12-volt terminal of his car. With the oil filter wrench at ground potential, and the terminal at 12 volts, a whole lot of current quickly passed through the wedding band. This ring became very very hot, very very fast. The result was a roasted, ring shaped pattern around the finger and a great deal of pain and suffering. All of us can learn from our military training and apply it to. home situations.

Rings have also caused serious injuries during on-the-job situations. A civilian employer, while stepping off a Coles Crane, reached for a place to hold and caught his ring on a protruding edge — thereby transferring his entire body weight to his ring — resulting in the loss of his index finger. Similar situations have occurred in aircraft and missile activities. Each of us can prevent similiar injuries by recognizing the potential danger of wearing rings.

SAC SAFETY SCREEN

509 BMW, Pease Crew E-111: P Capt Eugene C Paltrineri, CP Capt Robert L Alley, N Capt Michael W Hughes, BO MSgt Edward A Maloof

416 BMW, Griffiss Crew R-108: FP Capt Rade M Baida, CP Capt James Kieltyka, IN Capt John C Sellers Jr, IBO Sgt Frederick J Bookwalter

416 BMW, Griffiss Crew E-05: IP Capt Clifden A Banner, FP 1Lt Francis H Ayers Jr, RN Capt Robert N Magnuson, NN 1Lt James E Boynton Jr, EW 1Lt William T Lawrence, IS Sgt Leonard H Rak

410 BMW, K I Sawyer Crew E-04: AC Capt Cameron K Green, CP 1Lt Robert C Winterrowd, RN Capt Charles S Froebe, N 1Lt Paul J Kendrick, EWO 1Lt Corrie J Kundert, G Sgt Stephen R Snell

341 SMW, Malmstrom Crew E-113: MCCC Capt Donald G Mullins, DMCCC 2Lt Rafael Pubillones

321 SMW, Grand Forks Crew E 143: MCCC 1Lt Phillip J Crawford, DMCCC 2Lt Duane A Lukasek

320 BMW, Mather Crew R-15: P Capt Andrew W Smoak, CP 1Lt Kenneth G Schramm, RN Capt Stephen M Lightner, NN 1Lt William T Horton, EW 1Lt Randolph R Rihner, G SSgt Ray T Zamora

68 BMW, Seymour Johnson Crew E-112: P Capt Calvin Banks Jr, CP 1Lt Richard A Shandor, N Capt Thomas J Land, BO A1C William E Ottani

68 BMW, Seymour Johnson Crew R-04: P Capt True E Homan, CP 1Lt Jimmy C Mann, RN Capt Stephen B Cheavens, N Capt Hector M Marquez, EWO 1Lt Richard N Durbin, G SSgt Malcolm K Morris

97 BMW, Blytheville Crew E-10: AC Capt John R Luce, CP 1Lt Gilbert D Johnson Jr, RN Capt James A Bowden, NN Capt Robert F Gilbert, EW 1Lt Jimmie R Luttrell, AG TSgt Albert F Marcon

97 BMW, Blytheville Crew E-121: AC Capt Francis X Gallagher, CP 1Lt Gary J Gaddy, CP 1Lt Philip M King, NN 1Lt Mark J May, BO SrA Roy L Rogers

96 BMW, Dyess Crew E-11: FP Capt Phillip E Litts, CP Capt Robert L Nielsen, CP Capt Peyton Wheeler III, NB Capt Stephen B Green, NN Capt Ronald D Cope, IE 1Lt Doyle C Daughtry, IG Sgt Kenneth L Johnson

91 SMW, Minot Crew E-011: MCCC Maj Robert K Thompson Jr, DMCCC 2Lt Daniel E Kearney

55 SRW, Offutt Crew E-111: IP Capt Lawrence E Ford, CP 1Lt David F Newell, N Capt James O Wright, BO Tsgt Robert W McMullin

44 SMW, Ellsworth Crew E-053: MCCC 1Lt Arnulfo S Alanis, DMCCC 2Lt Robert H Potter

42 BMW, Loring Crew E-107: P Capt William B Busse, CP 1Lt Stephen C Daniels, N Capt Michael W Bullington, BO SSgt Robert G Leach

9 SRW, Beale Crew S-34: P Capt David L Dickerson

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HALL OF FAME

TACTICAL FLYING

OVER TWENTY-ONE YEARS

170 AREFG, McGuire (NJANG)	NONE

OVER NINETEEN YEARS

171 AREFW, Greater Pittsburgh (PAANG)	Mar '58
157 AREFG, Pease (NHANG)	Jun '58
97 BMW, Blytheville	Aug '58

OVER EIGHTEEN YEARS

940 AREFG, Mather (USAFR)	May '59

OVER SEVENTEEN YEARS

307 AREFG, Travis	Sep '59

OVER SIXTEEN YEARS

19 BMW, Robins	Oct '60
151 AREFG, Salt Lake City (UTANG)	Feb '61
161 AREFG, Sky Harbor (AZANG)	Apr '61
126 AREFW, Chicago O'Hare (ILANG)	Apr '61
134 AREFG, McGhee Tyson (TNANG)	Aug '61

OVER FIFTEEN YEARS

340 AREFG, Altus	Feb '62
301 AREFW, Rickenbacker	Jul '62
96 BMW, Dyess	Aug '62

OVER TWELVE YEARS

160 AREFG, Rickenbacker (OHANG)	Dec '64
136 AREFW, Dallas NAS (TXANG)	Jun '65
320 BMW, Mather	Jul '65
452 AREFW, March (USAFR)	Sep '66

OVER TEN YEARS

92 BMW, Fairchild	Feb '67
55 SRW, Offutt	Jul '67
2 BMW, Barksdale	Aug '67

OVER NINE YEARS

319 BMW, Grand Forks	Dec '67
22 BMW, March	Feb '68

OVER EIGHT YEARS

5 BMW, Minot	Feb '69
42 BMW, Loring	Sep '69

OVER SEVEN YEARS

141 AREFW, Fairchild (WAANG)	Oct '69
28 BMW, Ellsworth	May '70

OVER FIVE YEARS

7 BMW, Carswell	Mar '72
101 AREFW, Bangor (MEANG)	Mar '72
416 BMW, Griffiss	May '72
305 AREFW, Grissom	Aug '72

OVER FOUR YEARS

376 SW, Kadena	Nov '72
379 BMW, Wurtsmith	Apr '73

ICBM

OVER THIRTEEN YEARS

381 SMW, McConnell	Nov '63
90 SMW, F E Warren	Jul '64
1 STRAD, Vandenberg	Sep '64

OVER TWELVE YEARS

308 SMW, Little Rock	Aug '65

OVER SEVEN YEARS

341 SMW, Malmstrom	Apr '70

OVER FOUR YEARS

390 SMW, Davis-Monthan	Jul '73

To gain listing in the Hall of Fame, a SAC or ARF unit must be Class A mishap-free for 48 months.